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(54) Title: POWDER-BASED AMMUNITION PROJECTILE HAVING TRAILING END HEAT AND BLAST BARRIER

(57) Abstract: A powder-based projectile for small caliber ammunition including a jacket having an open end, a core disposed within the jacket adjacent the closed end thereof and a heat and pressure resistant barrier disc disposed distally of the core adjacent the open end of the jacket. A portion of the length of the jacket at its open end is inwardly folded in overlying relationship to less than all of the barrier disc to engage and cover a portion of the barrier disc and lock the barrier disc and core within the jacket and to maintain the barrier disc in position to protect the core from heat and pressure resulting from the ignition and burning of gunpowder. A method for the manufacture of the projectile is disclosed.

POWDER-BASED AMMUNITION PROJECTILE HAVING TRAILING END HEAT AND BLAST BARRIER

RELATED APPLICATIONS

This application is a continuation-in-part of pending U.S. Serial No. 08/834,342, filed April 16, 1997, entitled: Powder-Based Ammunition Projectile Having Trailing End Heat And Blast Barrier and U.S. Patent No.: 5,789,698, issued August 4, 1998, entitled: Projectile for Ammunition Cartridge.

FIELD OF INVENTION

This invention relates to a heavy metal powder-based projectile for use in ammunition for small-bore weapons, including rifles and pistols.

BACKGROUND OF INVENTION

In applicant's pending application, Serial No.08/792,578, filed January 30, 1997, there is disclosed a heavy metal powder-based projectile for a weapon, particularly suited for a small-bore weapon having a rifled barrel, such pending application being incorporated herein in its entirety by reference. "Small bore" weapons are defined as those weapons of .50 caliber or smaller caliber. The weapon may be a rifle or a pistol.

In a powder-based projectile made up of a mixture of powders, one of which is a heavy metal such as tungsten or uranium, or a carbide such as tungsten carbide, the manufacture of the projectile presents various problems. These problems relate both to the manufacture of the

projectile and the performance of the projectile when fired for a weapon. In the present application, the term "heavy metal powder" is intended to include a carbide of the heavy metal powder, unless otherwise indicated expressly or by the context of the use of this term.

In the manufacture of a projectile which is made up of a mixture of a heavy metal powder or heavy metal carbide powder, the physical characteristics of the powders are such that powder metallurgy fabrication techniques are dictated. These techniques may include such steps as forming a quantity of the powder into a geometric body and sintering the powder to develop a self-supporting body, and/or mixing the metal or carbide powder with a binder metal powder and die-forming the mixture into a geometric body. Whether sintered or die-formed, the resultant projectile has hard and abrasive heavy metal powder particles exposed on the exterior surface of the resulting projectile. These exposed powder particles abrad, and eventually destroy, the rifling of a gun barrel, so that it has been proposed that there be a jacket of a soft, relatively light weight metal, such as copper, applied to the outer surface of the projectile. This jacket provides lubricity between the projectile and the weapon barrel as the projectile is expelled from the weapon. In this type projectile, the powder-based portion thereof becomes a core about which the jacket is formed.

In certain shooting applications, particularly military and law enforcement shooting situations, it is desired that the projectile be capable of maximum penetration of a target. Penetrating projectiles commonly include a tapered leading end, i.e. an ogive, which is intended to enhance the

penetrating power of the projectile. In powder-based penetrating projectiles, it has been proposed that the leading end of the projectile include a conical-shaped solid member which has high penetrating capability, and which is disposed within a complementary-shaped jacket adjacent the leading end of the projectile and with the apex of the conical body being aligned with the longitudinal centerline of the cylindrical jacket and facing toward the leading end of the projectile. This conical shaped body is commonly referred to as a penetrator. In this projectile, the powder-based core is generally cylindrical in geometry and is disposed rearwardly of the penetrator. In the manufacture of this type projectile, the penetrator is first placed within the cylindrical jacket and adjacent the closed pre-formed end of the jacket. Thereafter, the core is inserted into the jacket. A short length of the trailing end of the cylindrical jacket is commonly swaged inwardly toward the longitudinal centerline of the projectile to mechanically lock the core and/or penetrator within the jacket. To avoid overlaying portions of this length of the trailing end of the jacket, and avoid creasing or radial folds of the jacket material, the length of the trailing end of the jacket is chosen to be insufficient to fully cover the trailing end of the core, thereby leaving a portion of the trailing end of the core exposed to the heat and blast forces generated within the ammunition case when a round of ammunition is fired.

Accuracy of delivery of a projectile is of importance in any shooting situation, but is of great importance in competitive sport shooting and in certain military and/or law enforcement shooting situations. Of especial concern is the repeatability from projectile to projectile of accuracy of

delivery of the projectiles to a target.

SUMMARY OF THE INVENTION

The present inventor has found that accuracy of delivery of a powder-based projectile which has a portion of the trailing end of the core thereof exposed to the heat and blast forces generated by the burning powder within the case of a round of ammunition tends to dislodge powder particles from this trailing end of the core. These dislodged particles further have been found to create at least two deleterious effects. First, those particles which are dislodged substantially immediately upon the ignition and burning of the powder within the case tend to travel down the barrel of the weapon independently of the projectile and act as abraders of the weapon barrel. Second, the center of gravity of the projectile is altered by the loss of the dislodged powder particles. The quantity of particles dislodged is different from projectile to projectile so that there is no consistency in the degree of alteration of the center of gravity between projectiles. This unpredictable alteration of the center of gravity of the projectile causes the projectile to exhibit more or less tendency to "yaw" along its free flight path to a target, with resultant inaccuracy of delivery of the projectile to the target. This problem, in its more severe state, can actually lead to the projectile assuming a tumbling action during its free flight to a target.

In accordance with one aspect of the present invention, the inventor provides a heat and blast resistance barrier adjacent the flat trailing end of the core of the projectile

and within the jacket. Thereafter, the trailing end of the jacket is swaged inwardly toward the longitudinal centerline of the projectile to capture this barrier and the core, and any penetrator body, within the jacket. The preferred barrier comprises a thin metal disc having a substantially uniform density and thickness throughout the disc. Tin is one suitable metal for the barrier. Importantly, the barrier is locked in a position wherein its planar dimension is normal to, and concentric with, the longitudinal centerline of the projectile to ensure uniformity of location of the barrier from projectile to projectile, hence uniformity of the center of gravity from projectile to projectile. Projectiles of the present invention have been found to exhibit minimum yaw and enhanced accuracy of delivery to a target.

It is another object to provide a powder-based ammunition projectile having a heat and blast barrier disposed adjacent the trailing end thereof.

It is an object of the present invention to provide a powder-based ammunition projectile having enhanced accuracy of delivery to a target.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a representation, in section, of one embodiment of a projectile embodying various of the features of the present invention and intended as a penetrator type projectile to be fired from a rifle;

Figure 2 is an end view of the trailing end (left hand end as viewed in Figure 1) of the projectile depicted in Figure 1;

Figure 3 is an exploded view depicting the components of the projectile of Figure 1 prior to their assembly into a projectile;

Figure 4 is an exploded view depicting the components of a further projectile embodying various features of the present invention and prior to their assembly into a projectile, the depicted projectile being particularly useful in pistol ammunition;

Figure 5 is a schematic representation, in plan view, of the exterior of a projectile assembled from the components depicted in Figure 4 and embodying various of the features of the present invention;

Figure 6 is a representation, in plan view, of one embodiment of a barrier disc suitable for inclusion in a projectile according to the present invention;

Figure 7 is a schematic representation of a round of ammunition including a projectile embodying various of the features of the present invention; and

Figure 8 is a schematic representation of the steps of one embodiment of the method of the present invention.

DETAILED DESCRIPTION OF INVENTION

In accordance with one aspect of the present invention, there is provided a projectile for ammunition for a small bore weapon, i.e. a rifle or pistol of .50 caliber or smaller caliber. The projectile of this invention is powder-based, that is, the bulk of the projectile is formed from a blend of

powders which commonly exhibit a density equivalent to or greater than the density of lead.

With reference to the several Figures, there are depicted two embodiments of a projectile embodying various of the features of the present invention. In Figure 1 there is depicted, in section, a projectile 12 suitable for firing from a rifle, for example. This projectile includes an outer jacket 14 which includes a generally cylindrical body portion 16 of substantially uniform wall thickness, a tapered closed leading end 18 defining an ogive 20, and an open trailing end 22. In the embodiment depicted in Figures 1 and 3, within the jacket there is housed a conical strong metal penetrator 24, made of hard steel, for example, and intended to enhance the ability of the projectile to penetrate a target. In the depicted embodiment, the penetrator substantially fills the ogive portion of the jacket. A core 26 made up of a cold-compacted quantity of a blend of a heavy metal powder such as tungsten metal powder and a relatively light metal powder, such as tin metal powder, is disposed within the jacket adjacent the trailing end 25 of the penetrator. Preferably, the powder blend includes a quantity of a fine particle size oxidized polyethylene homopolymer. The quantity of the blended powder mixture is preferably cold-compacted, e.g. at room temperature, for example, in a die to form the core 26. In the embodiment depicted in Figures 1 and 3, the core is of a straight cylindrical geometry.

There is further included within the jacket a barrier disc 30 having one of its flat faces 29 disposed adjacent to and in covering relationship to the flat rear end surface 33 of the trailing end 35 of the core. This disc is of substantially uniform thickness and density throughout the

disc. Within the jacket, the disc is oriented with its planar flat faces 29 and 31 normal to and concentric with the longitudinal centerline 32 of the jacket. The disc further is of a diameter which is only slightly, e.g. a few thousandths of an inch, smaller than the internal diameter of the open trailing end of the jacket so that the disc will readily enter the open end of the jacket and snugly fit within the jacket.

The barrier disc of the present invention is necessarily heat and pressure resistant for protecting the core from the heat and pressure generated by burning gunpowder. In smaller caliber projectiles, e.g. .22 caliber, the heat and pressure experienced is less than the heat and pressure experienced by larger caliber projectiles such as .50 caliber projectiles. Tin, copper and various metal alloys having heat and pressure resistance substantially equivalent to these same properties of tin or copper are suitable candidates for the barrier disc of the present invention. Tin is preferred for smaller caliber projectiles and copper is preferred for the larger caliber projectiles. The thickness of the disc can vary, the major determinant of thickness being the ability of the disc to retain its integrity and shape when subjected to the heat and pressure associated with the burning gunpowder employed in a given round of ammunition. By way of example, in a 9mm projectile, a tin barrier disc of 0.750 inch thickness is suitable.

A relatively short length 34 of the trailing end of the jacket, e.g. a length of jacket which is less than the radius of the cylindrical portion 16 of the jacket, is folded inwardly, e.g. swaged, toward the longitudinal centerline 32 of the jacket and into contact with the rear face 31 of the disc, thereby locking the disc, the core and the penetrator within the jacket. Importantly, the disc covers the rear flat

face 33 of the trailing end 35 of the core so that none of the core is exposed exteriorly of the jacket. As so disposed, the disc is in position to serve as a barrier against the heat and blast forces which are exerted against the trailing end of the projectile upon ignition and burn of the gun powder 42 of a round of ammunition 44 which includes the present projectile 12 in the open end 46 thereof as depicted in Figure 7.

A further embodiment of a projectile of the present invention is depicted in Figures 4 and 5. The embodiment depicted in these Figures is intended to be fired from a pistol and includes a jacket 50 having a rounded, relatively blunt, nose portion 52, a cylindrical portion 54 and an open trailing end 56. Within this jacket there is inserted a core 58 formed of a powder blend as described hereinabove. This core may be preformed with a rounded leading end that substantially matches the interior geometry of the rounded nose portion of the jacket or it may be a straight cylinder as is depicted in Figure 4. A barrier disc 30 as described hereinabove is inserted in the jacket in overlaying and covering relationship to the trailing end 59 of the core 58. When employing a straight cylindrical core, the jacket, core and disc subassembly is placed in a die cavity and subjected to pressure applied to the rear face 31 of the disc in a direction parallel to the longitudinal centerline of the jacket. The applied pressure is sufficient to deform the leading end 62 of the core and cause it to conform to the rounded interior geometry of the nose portion of the jacket.

Thereafter, a length 64 of the trailing end of the jacket is swaged inwardly toward the longitudinal centerline 60 of the jacket and into engagement with the rear face 31 of the disc 30 to lock the disc and core securely within the jacket. A completed projectile of this embodiment is depicted in

Figure 5. The disc employed in this further embodiment of the present projectile 66 is substantially identical to, and is oriented within the jacket, in an manner identical to the deployment of the disc in the embodiment depicted in Figure 1. Further, the length 64 of the trailing end of the jacket which is employed to lock the core 58 and disc 30 within the jacket 50 is of a length less than the radius of the disc.

In either the embodiment depicted in Figure 1 or the embodiment depicted in Figure 5, as noted hereinbefore, the length of the trailing end of the jacket which is employed in locking the components of the projectile within the jacket, is selected to be less than the length of the radius of the barrier disc. This feature of the present invention provides for sufficient length of the jacket to permit swaging or otherwise forming the distal trailing end of the jacket inwardly toward the longitudinal centerline of the projectile and into contact with the rear face of the disc to lock the components of the projectile within the jacket. Importantly, this feature precludes overlapping of any portion of the jacket upon it being swaged inwardly and against the disc. Such overlap develops an unpredictable adverse effect upon the center of gravity of the projectile in that more or less of the metal jacket may be disposed nonconcentrically of the longitudinal centerline of the projectile. This condition causes the projectile to be erratic in its free flight to a target. Preferably, the length of the trailing end of the jacket which is reserved for inward forming thereof is limited to about one-half the length of the radius of the disc. This length of the jacket end is readily infolded toward the longitudinal centerline of the projectile without creasing or creating radial folds of the jacket as it is infolded. This requirement of the jacket dictates that the jacket be formed of a metal which is sufficiently ductile as will permit the

required inward forming of the metal without creasing or creating radial folds thereof. Copper, or an equivalent metal, is preferred as the metal for the jacket. In any event, the inwardly formed end of the jacket does not fully close the trailing end of the jacket, and in the absence of the barrier disc of the present invention, leaves the trailing end of the core exposed to the effects of heat and blast from burning gun powder within the case of a round of ammunition. In the present invention, the barrier disc covers this exposed area of the core and prevents the dislodgement of powder particles from the core upon the firing of the weapon.

In tests performed by the inventor, 9mm projectiles were fabricated in accordance with the present invention. Each projectile included a core formed from a combination of tungsten and tin metal powders and a fine particle size oxidized polyethylene homopolymer powder. The core was disposed within a copper jacket and a tin metal barrier disc was placed in covering relationship to the trailing end of the core. A length of .130 inch of the trailing end of the jacket was infolded toward the longitudinal centerline of the projectile and against the barrier disc to lock the disc and core securely within the jacket. Other 9mm projectiles were fabricated employing the same components and fabrication techniques, except that no barrier disc was included in the projectiles. These two sets of projectiles were loaded into rounds of ammunition, employing identical cases, primers, and gun powder charges. A series of firings of the two sets of projectiles was conducted. These tests showed that those projectiles having the barrier disc exhibited at least 35 % greater accuracy of delivery to a target than those projectiles which did not include the barrier disc. Further, in a commonly known sheet test, at 25 ft from the weapon muzzle, powder-based projectiles without the cap of the

present invention produced numerous secondary impacts on the sheet. The source of these secondary impacts was loose powder particles that had been dislodged from the trailing end of the core. Identical sheet tests performed with ammunition employing a barrier disc in the trailing end of the powder-based projectile did not produce secondary impacts upon the sheet.

In accordance with the depicted method of the present invention for producing a projectile, (Figure 8) there is selected a quantity of a heavy metal powder, e.g. tungsten powder, a quantity of a binder metal powder, e.g. tin powder, and a quantity of a fine particle size oxidized polyethylene homopolymer. These powders are blended. Thereafter a quantity of the blended powder is selected and die-formed into a core. This core, along with a barrier disc is inserted into the open end of a cylindrical metal jacket which has its opposite end closed. In one embodiment, this subassembly is thereafter subjected to a pressure applied to the disc and core in a direction parallel to the longitudinal centerline of the jacket sufficient to deform the core to the extent necessary to cause it to conform to the internal geometry of the jacket, particularly at the leading end (nose) of the jacket. In another embodiment, the leading end of the jacket may be provided with a penetrator or other component, in which case it is not necessary to apply a deforming pressure to the disc and core. In either embodiment, the trailing end of the jacket is infolded toward the longitudinal centerline of the jacket (projectile) and against the rear face of the barrier disc to lock the disc, core and any other component of the projectile, within the jacket. Preferably, this latter step is carried out in two phases. In the first phase, the distal trailing end of the jacket is die-formed only to the extent required to bend the trailing end of the jacket partially

radially inwardly of the jacket. Thereafter, this partially infolded end of the jacket is fully folded inwardly to cause the end of the jacket to contact the rear face of the barrier disc and effect the desired locking of the components within the jacket. Preferably, this two phase infolding of the end of the jacket is carried out by two forming dies, one of which is designed to perform only the initial infolding of the end of the jacket and the other of which is designed to complete the infolding of the end of the jacket. This feature of the method has been found to prevent the creasing or formation of radial folds of the jacket end as it is infolded against the barrier disc.

WHAT IS CLAIMED:

Claim 1. A powder-based projectile for small caliber gun ammunition having leading and trailing ends and a longitudinal centerline exhibiting enhanced accuracy of flight to a target and providing protection against abrasion of the barrel and other components of the gun by loose powder particles from the projectile, comprising

a nonsintered unitary core formed from a mixture of powders which includes at least one metal powder having a density greater than the density of lead, said mixture of powders being compacted at about room temperature under pressure into a self-supporting entity exhibiting a density greater than the density of lead, and having a flat end, said core being incapable of withstanding dislodgement of the powder particles thereof when subjected to the heat and pressure associated with the firing of the projectile from a gun,

a one-piece hollow jacket having a side wall of substantially uniform wall thickness, a closed leading end, an open trailing end, and a substantially cylindrical body portion disposed between said leading and trailing ends,

a heat and pressure resistant barrier disc having opposite flat surfaces and being of substantially uniform thickness and density, said disc having an outer circumference which is essentially equal to the inner circumference of said jacket adjacent said open trailing end thereof, whereby there is no portion of said core

disposed between the outer circumference of said disc and said inner circumference of said jacket,

said core and said barrier disc being received within said jacket and filling substantially all the interior volume of said jacket except for a portion of the length thereof adjacent the open trailing end of said jacket, said flat end of said core being disposed axially adjacent the trailing end of the projectile and oriented in a plane substantially normal to the longitudinal centerline of the projectile, said disc being disposed between said core and said open trailing end of said jacket and oriented with its opposite flat surfaces substantially normal to the longitudinal centerline of the projectile, said disc further being disposed in juxtaposition to said flat end of said core so that one of its flat surfaces is in contact with and covers said flat end of said core, and its opposite flat surface facing said open trailing end of said jacket, with no portion of said disc being disposed between said core and said side wall of said jacket,

said portion of the length of said jacket being inwardly formed toward the longitudinal centerline of the projectile and in overlying relationship to said opposite flat surface of said disc to cover a portion of said opposite flat surface of said disc and define a trailing end of the projectile which is of consistent configuration from projectile to projectile to thereby provide a consistent disconnect of the projectile from the gas stream adjacent the muzzle of weapon from which the projectile is fired, said inwardly formed portion of the length of said jacket further establishing and maintaining said core and disc within said jacket and

wherein said disc is positioned to protect said flat end of said core against the uncontrolled dislodgement and escape of powder particles from said trailing end of said jacket as a consequence of heat and pressure generated in the course of propulsion of the projectile from a gun to thereby effectively eliminate abrasion of the gun components by loose powder particles from the projectile.

Claim 2. The projectile of Claim 1 wherein the length of said jacket which is available to be inwardly formed is f a length that is less than the radius of said disc.

Claim 3. The projectile of Claim 2 wherein the short length of said jacket is of a length equal to about one-half of the radius of said disc.

Claim 4. A method for the manufacture of a non-sintered powder-based projectile for small caliber ammunition and having a longitudinal centerline comprising the steps of

selecting a one-piece hollow jacket having a side wall, a closed leading end, an open trailing end, and a substantially cylindrical body portion disposed between said closed and open ends,

forming a metal powder-based unitary core from a mixture of powders which includes at least one metal powder having a density greater than the density of lead, said mixture of powders being compacted at about room temperature under pressure into a self-supporting entity which exhibits a density greater than the density of lead, and having a flat end, said core being incapable of withstanding dislodgement of the powder particles thereof

when subjected to the heat and pressure associated with the firing of the projectile from a gun,

disposing said metal powder-based unitary core within said open trailing end of said jacket with said flat end of said core disposed adjacent said open trailing end of said jacket and aligned substantially normal to said longitudinal centerline of said jacket,

disposing a heat and pressure resistant planar barrier disc of uniform thickness and density within said jacket in contiguous overlying relationship to said flat end of said core and between said flat end of said core and said open trailing end of said jacket having an outer circumference which is essentially equal in size and configuration to the inner circumference of said jacket adjacent said open trailing end thereof with no portion of said disc being disposed between said core and said side wall of said jacket and no portion of said core being disposed between said disc and said inner wall of said jacket,

disposing said core, jacket and disc combination into a die and applying pressure to said disc and trailing end of said core to force said core to essentially fill said jacket, except for a portion of the length of said jacket at said open trailing end of said jacket, leaving said portion of the length of said jacket available to be inwardly formed toward the centerline of said jacket, said portion of the length of said jacket being insufficient to fully close said open end of said jacket upon being inwardly formed,

inwardly forming said portion of the length of said

jacket toward the longitudinal centerline of the projectile and into engagement with said disc to partially cover said disc and to lock said core and disc within said jacket and define a trailing end of the projectile which is of consistent configuration from projectile to projectile to thereby provide a consistent disconnect of the projectile from the gas stream adjacent the muzzle of weapon from which the projectile is fired, and with said disc in position to protect said flat end of said core against the uncontrolled dislodgement and escape of powder particles from said trailing end of said jacket as a consequence of heat and pressure generated in the course of propulsion of the projectile from a gun to thereby effectively eliminate abrasion of the gun components by loose powder particles from the projectile.

Claim 5. The method of Claim 4 wherein said barrier disc includes opposite flat surfaces and including the step of orienting the flat surfaces of said disc substantially normal to the longitudinal centerline of the projectile.

Claim 6. The method of Claim 4 wherein the inwardly formed portion of the length of said jacket has a length dimension that is less than the radius of said barrier disc.

Claim 7. The method of Claim 6 wherein the inwardly formed portion of the length of said jacket has a length dimension that is about one-half the radius of said barrier disc.

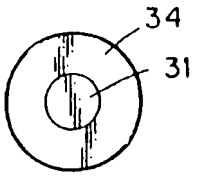

Fig. 2

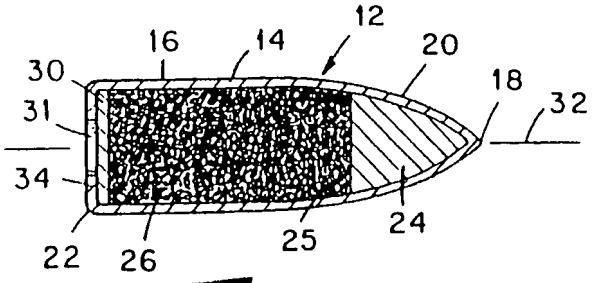

Fig. 1

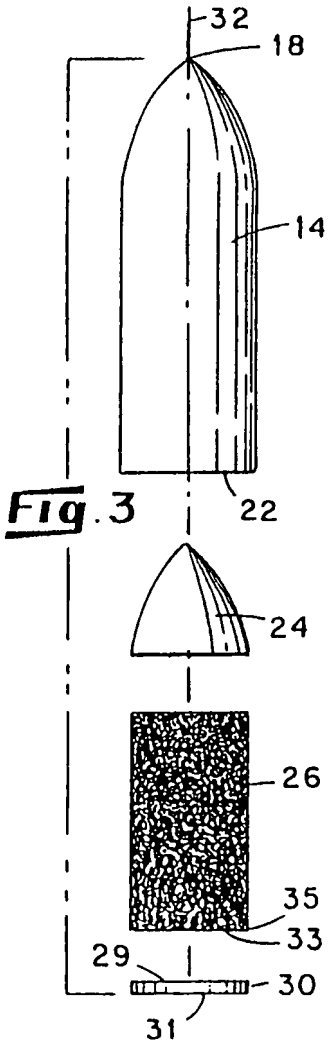

Fig. 3

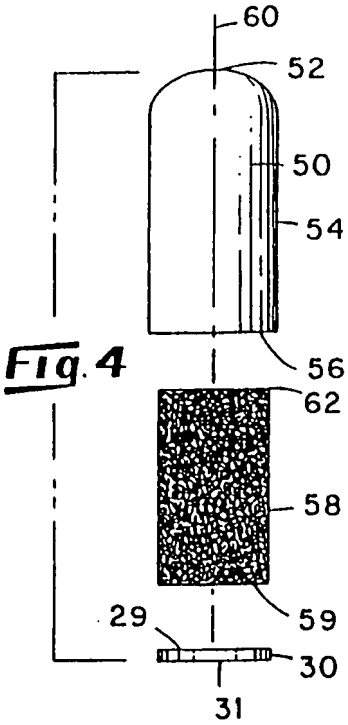

Fig. 4

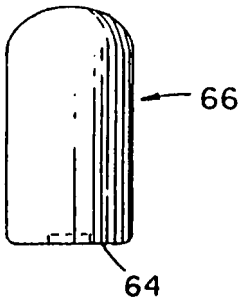

Fig. 5

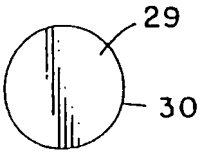

Fig. 6

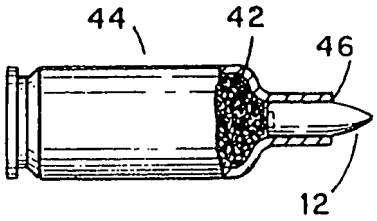

Fig. 7

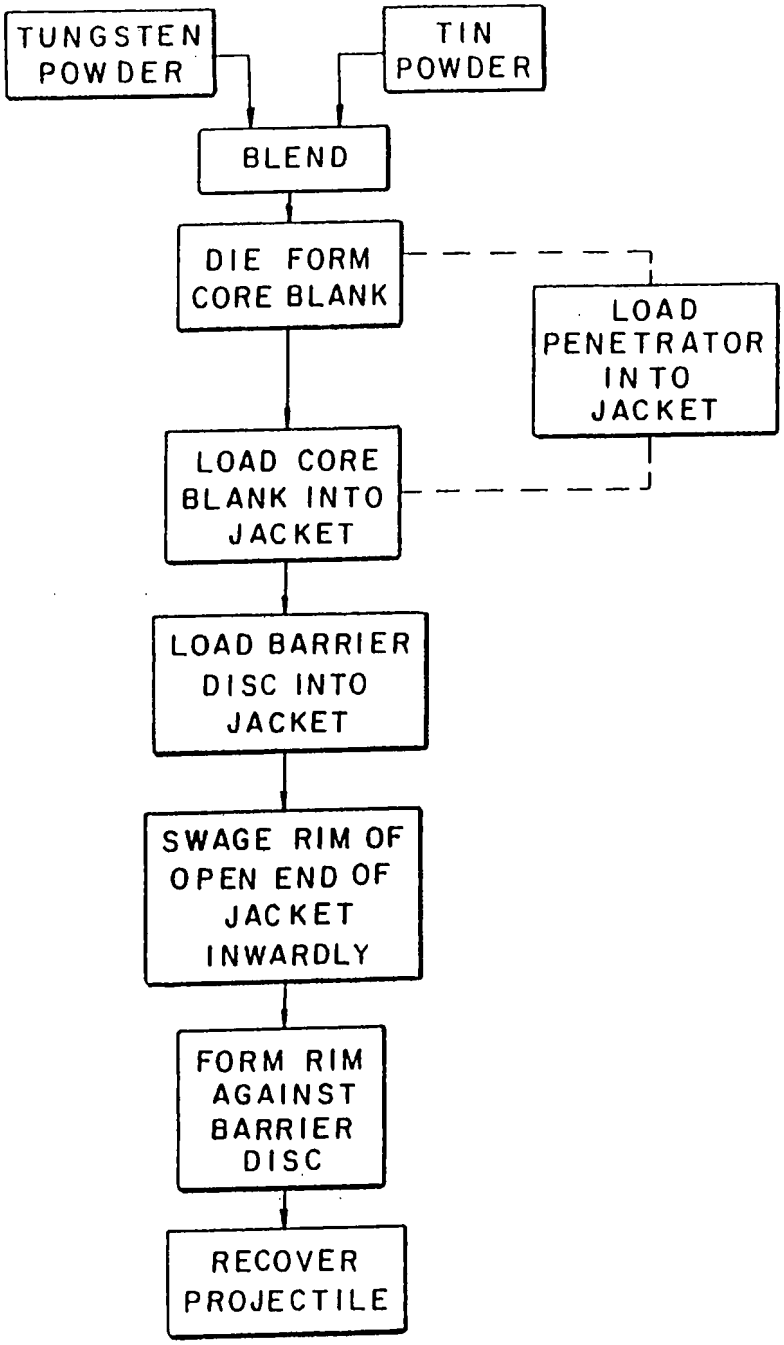
TUNGSTEN POWDER
TIN POWDER
BLEND
DIE FORM CORE BLANK
LOAD PENETRATOR INTO JACKET
LOAD CORE BLANK INTO JACKET
LOAD BARRIER DISC INTO JACKET
SWAGE RIM OF OPEN END OF JACKET INWARDLY
FORM RIM AGAINST BARRIER DISC
RECOVER PROJECTILE

Fig. 8